

# MILLWRIGHT APPRENTICE CURRICULUM

## 1<sup>ST</sup> YEAR APPRENTICE

### **INTRODUCTION TO CONSTRUCTION MILLWRIGHTING (2 CREDITS, 40 HOURS)**

1. Apprentice Orientation
2. Safety
3. Precision Tools
4. Power Tools
5. General Information

### **MATHEMATICS (3 CREDITS, 40 HOURS)**

1. Linear measurement
2. Angular measurement
3. Perimeter, area and volume of geometric shapes
4. Geometric construction
5. Metric orientation and conversion
6. Strength of Materials
7. Belts and pulleys, tracking RPM and diameters through simple and compound connections
8. Belt lengths, calculations for both conveyor and v-belts
9. Gears, tracking RPM and number of teeth through simple and compound connections
10. Ratios
11. Horsepower and torque

### **MONORAILS (2 CREDITS, 40 HOURS)**

1. I-beam monorail characteristics and installation
2. Trolley and chain installation
3. Guards
4. Power and free characteristics and installation
5. Enclosed tubular track
6. Twin section track
7. Truss and Girder Rails
8. Tow conveyors

### **BLUEPRINT READING (2 CREDITS, 40 HOURS)**

1. Conventional lines
2. Scales
3. Dimensions
4. Abbreviations
5. Symbols
6. Types of drawings
7. Interpretation of drawings

### **WELDING (2 CREDITS 2 PER YEAR)**

*40 hours per year for 4 years (160 hrs) taught through Eastern Iowa Community College*

1. Oxygen and acetylene cutting
2. Arc welding basics through certification preparation
3. T.I.G. welding; mild steel, stainless and aluminum
4. M.I.G. welding
5. Plasma arc

**WELDING EXTRA CREDITS**

1. AWS = D9.1 – 90 16g Stainless Steel (2)
2. AWS = D1.1 – 94 3/8" Plate H and V (2)
3. AWS = D1.1 – 94 1" plate H and V (2)

2<sup>ND</sup> YEAR APPRENTICE**CONVEYORS (2 CREDITS, 40 HOURS)**

1. Receiving shipment and Installation practices
2. Preparation of site
3. Conveyor supports and trusses
4. Drive terminal and power drives, identification and installation
5. Belt conveyor take-ups
6. Belt conveyor trusses
7. Decking
8. Characteristics
9. Belt idler construction, types and applications
10. Feeders, trippers and drives
11. Pulleys
12. Brakes and Backstops
13. Belting Construction and Installation
14. Belt Splices
15. Belt Cleaning Devices
16. Screw Conveyors, Assembly, Installation and maintenance
17. Couplings, Shafts and Drives
18. Bucket Elevators: Types and Assembly
19. Service Platforms

**INSTALLATION AND MAINTENANCE OF MACHINERY (2 CREDITS, 40 HOURS)**

1. Handling machinery; introductory rigging
2. Setting machinery; layout, leveling and centering
3. Machine assembly; layout, threads, components
4. Component assemblies, keys, screws, couplings, lubrication, alignment, chains, belts, bearings, gears.
5. maintenance; reducers, seals, gaskets, pumps, compressors, hydraulic cylinders

**SHAFT ALIGNMENT (2 CREDITS, 40 HOURS)**

1. Two rim and face procedures for coaxial alignment
2. Record keeping
3. Runout
4. Soft foot analysis
5. Indicator sag and corrective measures
6. Indicator interpretation
7. Alignment tolerances
8. Motor magnetic

**LAYOUT TASKS (3 CREDITS, 40 HOURS)**

1. Shop Layout; holes in roundstock, hole centers in a circle, measurements from center of slot, layout dimensioning of material

2. Field layout; baselines for machinery, centerlines, offset centerlines, piano wire for centerline, establishing angular centerline, layout of anchor bolts
3. Geometrical layout; find the center of a circle, construct various geometric shapes
4. Parallel line development
5. Triangulation
6. Curve-a mark

### 3<sup>RD</sup> YEAR APPRENTICE

#### **RIGGING (3 CREDITS, 40 HOURS)**

1. Estimation of weight; linear dimension of structural shapes x WT per foot  
Calculation of area x Mat'l WT P.S.F. Calculation of volume x Mat'l WT P.C.F.  
Hydraulic pressure x piston area = force.
2. Center of balance; Utilize geometric construction to locate center of balance, calculate center of balance between two or more masses.
3. Wire rope; identification, classification, construction, inspection, capacity, rule of thumb based on breaking strength, factor of safety.
4. Reeving; Theoretical mechanical advantage, actual mechanical advantage, using friction load tables, strength efficiency and connectors.
5. Slings; introduction to trigonometry tables and function calculator. Calculation of stress on a choker, calculation of stress on a basket hitch with inclined legs. calculation of stress on 3 and 4 part bridles, calculation of collapsing forces in bridles.
6. Chains; approved types and identification, inspection, load capacities, rule of thumb load capacities calculating safe working loads when manufacturer's factor of safety is not adequate for required factor of safety.
7. Hoists, winches and related devices; drum loading, establishing proper fleet angle, friction loss through system; stress on connecting points when ropes change direction, proper selection of snatch blocks.
8. Jacks, rollers and related devices, Calculation of force required to move an object up an inclined plane, using coefficient of friction, calculating force in a hydraulic system.
9. Rigging hardware; identification, inspection, application, load capacities.
10. Strength of materials; Proper selection of structural shapes (WF beams and channels) when used to support loads either cantilevered or spans.
11. International hand signals; Demonstration and test.

#### **OPTALIGN – LASER SHAFT ALIGNMENT (2 CREDITS, 20 HOURS)**

1. Identification of equipment.
2. Safety.
3. Set –up, record keeping, simple alignment procedure.
4. Explanation and application of all computer functions.

#### **ADVANCED SHAFT ALIGNMENT (3 CREDITS, 40 HOURS)**

1. Reverse alignment calculations
2. Reverse alignment graphical analysis
3. Jackshaft alignment (below critical speed)
4. Jackshaft alignment (above critical speed)
5. Alignment of machine trains

6. Graphical and mathematical calculations for thermal growth targets

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### **HYDRALICS (2 CREDITS, 20 HOURS)**

1. An introduction to hydraulics; define pressure, conservation of energy, hydraulic power transmission, advantages of hydraulics, oil, pressure in a column, creation of pressure, work, power, horsepower, torque, system design
2. Principles of power hydraulics; principles of pressure and flow, graphical symbols
3. Hydraulic fluids, purpose of fluids, quality requirements, properties
4. Hydraulic fluids conductors and seal; material considerations, installation of seals, seals and leakage, seal material
5. Reservoirs; functions, components, design sizing
6. Contamination control; effects of contamination, measuring contamination, using component contamination tolerance ratings, sources of contamination, techniques for minimizing contamination during assembly and servicing, filters.
7. Actuators; cylinders, motors
8. Directional valves, identification and application
9. Flow controls; methods, temperature compensation, proportional flow control valves
10. Hydraulic pumps; displacement, delivery, efficiency, pump rating, types of pumps
11. Accessories; accumulators, applications, intensifiers, pressure switches, instruments, sound damping devices

### **OPTICAL LEVELING (2 CREDITS, 20 HOURS)**

1. Equipment identification and nomenclature
2. Tribrach and 4-post leveling bases
3. Reading an optical micrometer and wyteface scale
4. Balance pointing procedure
5. Field book records
6. Line leveling procedure
7. Area leveling procedure
8. Interpretation of readings
9. Pointing repeatability

### **BEARINGS SEALS AND LUBRICATION (2 CREDITS, 20 HOURS)**

1. Understanding sleeve bearings
2. Identification and application
3. Sleeve bearing fitting procedure and check
4. Sleeve bearing load capacity
5. Proper location and cutting of lubrication grooves
6. Variations of lubricants and applications
7. Explanation of hydrodynamic wedge
8. Antifriction bearings
9. Nomenclature
10. Types and functions
11. Standard and Precision
12. Installation procedures – reduction of clearance
13. Importance of free and help bearings
14. Inspection
15. Bearings failures and causes
16. Lubricant function

17. Pillow block bearings – variations of design and application
18. Seals – design, application, installation and removal.

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4<sup>TH</sup> YEAR APPRENTICES

**SUPERVISORY TRAINING SHORT TERM SCHEDULING (1 CREDIT, 20 HOURS)**

1. **Motivation:** Attendees learn to apply the three major theories of motivation and understand what motivates a person to work, to distinguish between ability and attitude problems of workers, to appreciate and to deal effectively with production teams and individuals.
2. **Leadership:** Participants are introduced to styles and methods of leadership action based on the situation and the people involved.
3. **The Supervisor's Role:** Participants learn the supervisor's role of being between management and production, what is expected of each and how to adapt to the transition of being a supervisor.
4. **Communication:** program participants learn the communication process, how to overcome the barriers to communication and will develop skills in giving and receiving instructions.
5. **Goal Setting:** Attendees learn the essentials of organizing, planning and scheduling; how to budget production for short periods and provide control to keep on schedule and within budget.
6. **Negotiating Commitment:** Supervisors learn the importance of receiving commitments for the quantity and quality of production so that individuals feel personally accountable for production that meets or exceeds the schedule.
7. **Coaching and Training:** Participants learn both the coaching and training processes and how to apply each in the development of a production team.

**OPTICAL ALIGNMENT – IS IT STRAIGHT, FLAT, PLUMB AND SQUARE? (3 CREDITS THREE 40 HOURS)**

1. Optical Level
  - a. Definition of a level and its operation
  - b. Identification of Parts
  - c. Mounting on Tripod and Proper Leveling Procedure
  - d. Micrometer Installation and Explanation
  - e. Pegging procedure
  - f. Introduce the wyteface scale and explain significance of double line centering
  - g. Practical experience using level and wyteface scale transferring bench or elevations and leveling.
2. Jig Transit
  - a. Definition of a Jig Transit and its uses
  - b. Identification of parts and their functions
  - c. Bucking in procedures
  - d. Establishing precision 90 degrees working plant
    1. Collimation
    2. Auto-collimation
    3. Auto-Reflection
    4. Use of a penta prism
    5. Use of a jig transit square

3. Alignment Telescope
    - a. Definition and identification of parts
    - b. Discuss use of the alignment telescope
    - c. Demonstrate mounting procedure
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- d. Demonstrate mounting and use of optical square
  - e. Discuss bore alignment
  - f. Discuss alignment of rotating shafts that have excessive distance between shaft faces
4. Theodolite
    - a. Definition of a theodolite and introduction of parts
    - b. Demonstrate leveling procedure and mounting
    - c. Explain elevation changes during leveling procedure
    - d. Explain optical scale reading – Degrees, minutes, seconds
    - e. Face to face checks and calibration of instruments

#### **UNDERSTANDING THE OPERATION OF PUMPS (2 CREDITS, 20 HOURS)**

1. Pump development and application
2. Basic pump hydraulics
3. End suction centrifugal pumps
4. Propeller and turbine pumps
5. Rotary pumps
6. Reciprocating pumps
7. Metering pumps
8. Special purpose pumps
9. Packings and seals
10. Pumps maintenance

#### **AIR COMPRESSORS AND BLOWERS (1 CREDIT, 20 HOURS)**

1. Reciprocating compressors – Identification and nomenclature
2. Valve removal and disassembly, inspection and repair
3. Valve unloader disassembly, inspection and repair
4. Piston and piston rod removal
5. Piston and cylinder measurements
6. Piston ring installations
7. Piston ring installations
8. Piston and piston rod installation
9. Piston-to-cylinder head adjustment
10. Crosshead shim procedure
11. Rotary blower disassembly and inspection
12. Timing gear removal, installation and adjustment
13. Installation of bearings and seals

#### **ADVANCED OPTAGLIGN (2 CREDITS, 20 HOURS)**

1. Vertical shaft alignments
2. Measuring horizontal shaft deflection
3. Calculating critical speed
4. Laser procedures for above and below critical speed

## **TURBINE-GENERATOR AND REACOTR INSTALLATION (2 CREDITS)**

1. Foundation, anchors and grouting
2. Turbine components, installation and alignment
3. Generator components, installation and alignment
4. Exciter installation

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5. Turbine couplings, aligning rotor sections
6. Auxiliary equipment, pipes, turning rear, pumps, fans, condenser, lubrication
7. Nuclear reactor; operation, safety, identification

## **SAFETY**

1. All courses specify specific safe working practices and requirements necessary to complete field and classroom work in each area.
2. Millwright 16 Hour Safety
3. Confined space
4. Material Safety Data Sheets
5. Lift Truck
6. Areal Lift
7. MSHA
8. Ergonomics
9. Scaffold Users
10. Other courses a may be required for the industry